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(54) Film antenna apparatus.

(37) An antenna apparatus in which flexible antennas made of a conductive material are formed on a flexible insulating sheet. An insulating film (11) made of a synthetic resin material is used as the insulating sheet, and the antennas are formed by adhering a metal foil (12, 13) on the insulating sheet or by depositing a metal film on the insulating sheet.

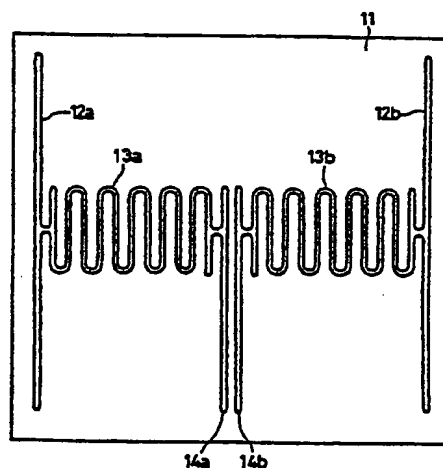


FIG. 1

EP 0 274 592 A1

### Film antenna apparatus

The present invention relates to a film antenna apparatus having flexibility and, more particularly, to a thin, light, and flexible antenna apparatus which can be folded in a compact size to be housed and carried, and which can be adhered on or embedded in a surface of a wall or furniture and hence does not degrade an interior design.

In general, as for a VHF/UHF antenna for outdoor use, Yagi-type antennas constituted by metal pipes are widely used. In addition, a variety of antenna apparatuses constituted by metal pipes are used also for indoor use. However, since shapes and sizes of these antenna apparatuses are limited to obtain necessary characteristics, it is difficult to realize a good design. Moreover, these antenna apparatuses have three-dimensional shapes and hence occupy large spaces as a whole.

Therefore, when an antenna apparatus as described above is adopted especially for indoor use, an interior design is often degraded. Furthermore, such an antenna apparatus is disassembled or folded and then housed in a box or the like to be stored or transported. However, it is troublesome to assemble the apparatus when it is to be used.

In order to eliminate the above drawbacks, plate-like VHF/UHF antenna apparatuses have been developed. One of these antenna apparatuses is disclosed in U.S. Patent No. 2,821,710 to Hall. This antenna apparatus comprises an antenna component sandwiching an antenna element consisting of metal wires between two electrically insulating plates or sheets. This apparatus can be placed, e.g., behind a picture frame. Since the antenna element of this apparatus cannot be seen from outside, this apparatus does not degrade an interior design. However, since this antenna apparatus cannot be bent or folded, it is inconvenient to store or transport the apparatus.

An antenna apparatus similar to that disclosed in the U.S. Patent of Hall is disclosed in U.S. Patent No. 3,587,105 to Neilson.

In addition, so-called plate-like printed antenna apparatuses each obtained by printing an antenna element on an electrically insulating substrate are disclosed in U.S. Patent No. 3,587,110 to Woodward and U.S. Patent No. 3,780,373 to Holst et al. Similar to the above apparatuses, these antenna apparatuses can be incorporated behind a picture or the like.

Moreover, U.S. Patent No. 3,754,269 to Clavin et al. discloses an omnidirectional antenna apparatus obtained by adhering a band of a flexible conductive material on a flexible electrically insulating material and winding the resultant structure

around a radome. However, this antenna apparatus is to be mounted on a large radome and hence is not suitable for receiving TV or FM programs.

The present invention has been made to eliminate the above drawbacks. It is, therefore, an object of the present invention to provide a film antenna apparatus having flexibility which can be cylindrically rolled up or folded to be housed in a compact space, and hence can be conveniently stored or transported. It is a second object of the present invention to provide a thin and light film antenna apparatus which can be adhered on a wall or furniture of a room, can be stacked integrally with, e.g., a poster or a calendar, and hence does not degrade a room interior design.

The above objects of the present invention can be achieved by providing an antenna made of a flexible conductive material on a sheet made of a thin flexible electrically insulating material.

According to an embodiment of the present invention, a thin film made of a synthetic resin material or paper is used as the above sheet, and an antenna element such as a thin aluminum foil having flexibility and a predetermined shape is adhered on the surface of the film. According to another embodiment, a conductive material such as aluminum is deposited on the surface of the film. According to still another embodiment of the present invention, cloth or non-woven fabric is used as the above sheet, and conductive thin wires are woven therein or a conductive material is coated or deposited thereon to form an antenna element.

Such an antenna apparatus can be adhered on a wall of a room, or incorporated in furniture or an electric appliance. In addition, such a thin and flexible antenna apparatus can be incorporated in, e.g., a poster, a calendar, or a tapestry. Moreover, the above antenna apparatus is formed to have a cylindrical shape or other three-dimensional shapes, thereby providing both a good design and predetermined characteristics as an antenna.

The present invention will be apparent from the following description of embodiments taken in conjunction with the drawings, in which:

Fig. 1 is a plan view of an antenna apparatus according to an embodiment of the present invention;

Fig. 2 is a plan view of an antenna apparatus according to another embodiment of the present invention;

Fig. 3 is a plan view of an embodiment of an antenna apparatus used also as a poster;

Fig. 4 is a partially enlarged plan view of the embodiment shown in Fig. 3;

Fig. 5 is a perspective view showing how the antenna apparatus of Fig. 3 is used;

Fig. 6 is a plan view of another embodiment of the antenna apparatus used also as a poster;

Fig. 7 is a plan view of an antenna apparatus according to still another embodiment;

Fig. 8 is a partially cutaway plan view of a terminal box of the embodiment shown in Fig. 7;

Fig. 9 is a sectional view taken along line 9 - 9 of Fig. 8;

Fig. 10 is a bottom view of a box of the terminal box of Fig. 8;

Fig. 11 is a side view of the rear plate of Fig. 9;

Fig. 12 is a plan view of an antenna apparatus having a short-circuit portion different from that shown in Fig. 7.

Fig. 13 is a plan view of an antenna apparatus having two types of antennas;

Fig. 14 is a partially cutaway plan view of a terminal box used in the embodiment shown in Fig. 13;

Fig. 15 is a sectional view taken along line 15 - 15 of Fig. 14;

Fig. 16 is a plan view of an embodiment of another terminal box;

Fig. 17 is an exploded side view of the terminal box of Fig. 16;

Fig. 18 is a sectional view taken along line 18 - 18 of Fig. 17;

Fig. 19 is an exploded perspective view of an embodiment of another terminal box;

Fig. 20 is a schematic view of an antenna system using an antenna apparatus according to the present invention;

Fig. 21 is a plan view of an antenna apparatus having two antennas;

Fig. 22 is a cross sectional view taken along line 22 - 22 of Fig. 21;

Fig. 23 is a plan view of a feeder used in an antenna apparatus according to the present invention;

Fig. 24 is a cross sectional view taken along line 24 - 24 of Fig. 23;

Fig. 25 is a plan view of an antenna apparatus incorporated in a picture frame;

Fig. 26 is a perspective view of an antenna apparatus incorporated in a television set;

Fig. 27 is a perspective view of an antenna apparatus incorporated in a game board;

Fig. 28 is a perspective view of an antenna apparatus incorporated in a lamp shade;

Fig. 29 is a perspective view of an antenna apparatus formed cylindrically;

Fig. 30 is a plan view of an antenna apparatus used also as a tapestry; and

Fig. 31 is a perspective view of an antenna apparatus incorporated in an umbrella.

Embodiments of the present invention will be described below with reference to the accompanying drawings. Fig. 1 shows an embodiment of a main part of an antenna apparatus according to the present invention. In Fig. 1, reference numeral 11 denotes an electrically insulating sheet. In this embodiment, a 0.125 mm thick film formed of a synthetic resin material such as polyester, polyamide, or vinyl chloride is used as the sheet. However, paper, a sheet obtained by stacking paper and a synthetic film, or the like may be used depending upon applications. Film 11 is thin and flexible and is formed of a transparent material. A pair of antennas 12a and 12b for receiving, e.g., FM programs, are formed on the surface of film 11. Antennas 12a and 12b include band-like extension coils 113a and 13b bent to have a wave shape. Each antenna is obtained by cutting out a predetermined shape from a foil formed of a conductive material such as aluminum or copper and is adhered on the surface of film 11 with an adhesive.

Antennas 12a and 12b may be formed by depositing a conductive film on film 11 to have a predetermined shape by vapor deposition or the like. In this case, prior to vapor deposition, a predetermined masking member may be stacked on film 11 so that the conductive film is deposited on only a predetermined portion. On the other hand, after the conductive film is deposited on the entire surface of the insulating film, unnecessary portions may be removed by etching so that the film having a predetermined shape remains.

Feeder portions 14a and 14b extend from end portions of coils 13a and 13b, respectively. A feeder (not shown) is connected to the distal end portions of feeder portions 14a and 14b through proper connection terminals. If the above antennas, extension coils, and feeder portions are formed of a copper material, a feeder may be soldered directly to the distal end portions of feeder portions 14a and 14b.

The above antenna apparatus can be mounted on a window glass of a vehicle or of a building. In this case, since film 11 is transparent, a field of vision is not interfered. Such an antenna apparatus can be adhered on a window glass or a wall using a variety of known adhesives, pressure sensitive adhesives, pins, or other metal fittings.

Fig. 2 shows another embodiment. This embodiment is an antenna apparatus for receiving TV programs and has an arrangement similar to that of the embodiment shown in Fig. 1 except that a shape of an antenna element of this embodiment corresponds to a frequency band to be received. In the embodiment of Fig. 2, antennas 21a and 21b for receiving a VHF band, antenna 22 for receiving

a UHF band, and auxiliary terminals 23a and 23b are formed. Antennas 21a and 21b are bent along an edge portion of substantially square film 11, thereby making the entire antenna apparatus compact. End portions of antennas 21a and 21b are formed to be feeder portions 24a and 24b, and end portions of antenna 22 are formed to be feeder portions 25a and 25b, respectively. Terminal portions 23a and 23b are used when reception signals from the two antennas are to be mixed with each other by a pair of feeders (not shown) and extracted.

Figs. 3 and 4 show an embodiment in which the antenna apparatus as shown in Fig. 2 is incorporated in a poster. In Figs. 3 and 4, reference numeral 111 denotes a flexible insulating film; 112a and 112b, antennas for receiving a VHF band; 113, an antenna for receiving a UHF band; and 116a and 116b, auxiliary terminals. An arrangement of this embodiment is substantially the same as those of the embodiments shown in Figs. 1 and 2. Feeder portions 114a and 114b are formed at end portions of antennas 112a and 112b, and feeder portions 115a and 115b are formed at end portions of antenna 113, respectively. On film 111, photograph 120a of singers is printed inside antenna 113, and patterns and characters 120b are printed between antennas 112a and 112b and antenna 113. Note that band-like antennas 112a, 112b, and 113 are used as frame lines of portions where the photograph and the patterns are printed. Holes 121a to 121d are formed at corners of film 111, so that the antenna apparatus used also as a poster is adhered on a wall or the like by pins piercing through these holes. When a VHF signal from antennas 112a and 112b and a UHF signal from antenna 113 are to be mixed with each other and supplied through single signal line 117 as shown in Fig. 4, line 117 is connected to terminals 116a and 116b, coils 118a and 118b are connected between feeder portions of antennas 112a and 112b and terminals 116a and 116b, and capacitors 119a and 119b are connected between feeder portions of antenna 113 and terminals 116a and 116b, thereby forming a mixing circuit.

Photograph 120a and patterns and characters 120b may be printed directly on the surface of film 111, or a transparent film on which the above photograph, characters, and the like are printed at predetermined portions may be stacked on film 111. In the latter case, since the transparent film stacked on film 111 covers the antennas, the antennas are effectively protected.

The above antenna apparatus used also as a poster is adhered on a wall of a room as shown in Fig. 5 and is connected to feeders 117V, 117U, and the like. The antenna apparatus according to this embodiment does not degrade a room interior

design.

Fig. 6 shows an antenna apparatus used also as a poster for receiving only a VHF band. In this apparatus, antennas 112a and 112b for receiving a VHF band are formed to be bent along an edge portion of an insulating film, and photograph 123a, characters 123b, and the like are printed at a central portion of the insulating film. Note that this embodiment has substantially the same arrangement as that shown in Fig. 3. According to this embodiment, since antennas 112a and 112b are arranged along the edge portion of the insulating film and hence are not conspicuous and printing can be arbitrarily performed at the central portion, a poster can be freely designed.

Figs. 7 to 11 show an embodiment of an antenna apparatus comprising a terminal device. In Figs. 7 to 11, reference numeral 211 denotes a flexible insulating film. Linear antennas 201 and wave-like extension coils 202 both made of a thin-film-like conductive material are formed on film 211. Linear short-circuit portions 203 are formed at base portions of coils 202. Feeder portions 204 are connected to the base portions of coils 202. An arrangement of a main body of this antenna apparatus is substantially the same as that of the antenna apparatus of Fig. 1.

Feeder terminal box 213 is provided at a corner of film 211. The antenna apparatus is connected to feeder 215 through box 213, and feeder 215 is connected to a receiving unit through terminal 216. Switch 214 for switching receiving sensitivity is provided to box 213.

Box 213 is arranged as follows. That is, in Figs. 8 and 9, reference numerals 217 and 217' denote leaf springs; 218 and 218', output terminals; and 219 and 219', slide terminals. When switch 214 is moved in an arrow direction of Fig. 8, slide terminals 219 and 219' are moved together with switch 214 and separated from springs 217 and 217' and output terminals 218 and 218'. Capacitors 220 and 220' are connected between the leaf springs and the output terminals, respectively. Therefore, when the slide terminals are in contact with the leaf springs and the output terminals, the leaf springs and the output terminals bypass the capacitors and hence are short-circuited with each other. On the other hand, when the slide terminals are moved away from the leaf springs and the output terminals, the capacitors are connected in series between the leaf springs and the output terminals. Therefore, by operating switch 214, capacitors 220 and 220' can be inserted in or removed from the circuit.

As shown in Fig. 9, springs 217 and 217' are urged against end portions of feeder portions 204. Rear plate 223 is placed behind box 213 so that film 211 is sandwiched therebetween. Four projec-

tions 224 are formed on plate 223 as shown in Fig. 11, and four holes 225 are formed in box 213 at positions corresponding to the projections. Projections 224 of the rear plate extend through four holes formed at corners of film 211 and are fitted in holes 225 so that the terminal box and the rear plate are coupled with each other while sandwiching film 211 therebetween.

According to the above embodiment, box 213 is easily mounted at the corner of film 211. Therefore, the feeder can be easily connected to the antenna apparatus. In addition, by operating switch 214 provided to the terminal box, the characteristics of the antenna apparatus can be varied in correspondence with a frequency band to be received. That is, when switch 214 is operated to separate slide terminals 219 and 219' away from springs 217 and 217' and output terminals 218 and 218', short-circuiting between springs 217 and 217' and output terminals 218 and 218' is eliminated, and capacitors 220 and 220' are connected in series therebetween. Therefore, inductive reactance of the antenna apparatus is cancelled by capacitive reactance of the capacitors, and a resonant frequency of the antenna apparatus transits to a higher frequency. On the other hand, when switch 214 is moved in the opposite direction to short-circuit the leaf springs and the output terminals by the slide terminals, the above capacitors are disconnected, and the resonant frequency of the antenna apparatus transits to a lower frequency. That is, the resonant frequency of the antenna apparatus can be selected in correspondence to a frequency band to be received. Note that in this embodiment, each of capacitors 220 and 220' has a capacitance of about 47 pF.

Moreover, according to this embodiment, since short-circuit portions 203 are formed at the base portions, i.e., the feeder-side end portions of coils 202, impedance match with respect to a receiving apparatus can be easily obtained. That is, according to a dipole antenna having extension coils 202 bent to have a wave shape as in this embodiment, total length  $L$  can be reduced to make the entire antenna apparatus compact. On the other hand, if width  $H$  of coils 202 is increased, radiation resistance at the feeder-side end portions is reduced. As a result, in the characteristics of the antenna apparatus, a frequency locus on the Smith chart is widened to make it difficult to obtain the impedance match with respect to the receiving apparatus. However, according to this embodiment, since the wave-like extension coils are partially short-circuited by linear short-circuit portions 203, these portions equivalently constitute a thick dipole antenna. As a result, over reduction in the radiation resistance can be prevented, and frequency locus on the Smith chart is not widened, thereby providing

an antenna apparatus having the characteristic by which the impedance match with respect to the receiving apparatus can be easily obtained. Note that since a current distribution at coils 202 is maximized at the feeder-side end portions, it is effective to form the short-circuit portions at the feeder-side end portions, i.e., the base portions of the extension coils.

Fig. 12 shows another embodiment of the short-circuit portions. In this embodiment, wide band-like short-circuit portions 204 are formed at base portions of extension coils 202. This embodiment can achieve the same effect as that obtained by the embodiment shown in Fig. 7.

Figs. 13 to 15 show an antenna apparatus comprising antennas for receiving both VHF and UHF bands. In this apparatus, antenna 231 for receiving a UHF band and antennas 233 and 233' for receiving a VHF band are formed on insulating film 211. A structure of this antenna apparatus is substantially the same as that of the antenna apparatus shown in Fig. 7. Feeder terminals 232 and 232' are connected to the UHF receiving antenna, and feeder terminals 235 and 235' are connected to the VHF antennas. Four holes 236 are formed at corners of film 211 for mounting a terminal box which is substantially the same as that of the embodiment of Fig. 7. Note that reference numerals 234 and 234' denote portions for obtaining impedance match. As shown in Figs. 14 and 15, according to a terminal box used in this embodiment, VHF feeder 240 and UHF feeder 241 are respectively connected to the VHF receiving antennas and the UHF receiving antenna. This terminal box comprises leaf springs 237, slide terminals 238 and 238', and output terminals 239 and 239' and has an arrangement substantially similar to that of the terminal box shown in Fig. 8.

Figs. 16 to 18 show another embodiment of the terminal box. An arrangement of this terminal box is suitable for an antenna apparatus in which antennas and feeder portions are formed by printing a conductive paint. That is, such a conductive paint generally contains a silver powder, a carbon powder, or the like and hence is given conductivity by these powders. Therefore, it is difficult to bring the feeder portions formed by coating such a conductive paint into contact with feeder terminal members, often resulting in poor contact.

In Figs. 16 to 18, reference numeral 311 denotes an insulating film, and feeder portions 312 and 312' formed by coating a conductive paint including a silver powder, a carbon powder, or the like are formed on film 311. Reference numerals 313 and 313' denote feeder terminal plates; and 314 denotes a front plate. Terminal plates 313 and 313' are mounted to front plate 314. Reference numeral 321 denotes a rear plate, and film 311 is

sandwiched between the rear and front plates. Note that two-side adhesive tape 323 is adhered on the upper surface of rear plate 321 to fix the insulating film with the rear plate. Two holes 319 and 319' are formed in front plate 314, and nuts 322 and 322' are provided to rear plate 321. Two bolts are threadably engaged with nuts 322 and 322' through holes 319 and 319' and holes 320 and 320' formed in film 311. By tightening the bolts, film 311 is sandwiched between the front and rear plates and fixed therein. Feeder terminal plates 313 and 313' are mounted to front plate 314. Each feeder terminal plate is U-shaped and fitted on an edge portion of the front plate. Twin-lead type feeder 318 is connected to ends of terminal plates 313 and 313' by solder 324. Cover 316 provided to cover the soldered portion is mounted on front plate 314 by screw 317. By tightening forces of bolts 315 and 315', other end portions of terminal plates 313 and 313' are urged against feeder portions 312 and 312'. In this embodiment, the feeder terminal plates are strongly urged against the feeder portions by the tightening forces of the bolts and hence electrically contact therewith reliably.

Fig. 19 shows still another embodiment of the feeder terminal box. This terminal box comprises main body 454 made of, e.g., a synthetic resin, and cover 457 is provided to body 454 to be freely opened/closed through a thin portion which serves as a hinge. Elastic U-shaped terminal members 456 are provided in body 454 and connected to a feeder. Fitting holes 460 and positioning holes 459 are formed in an edge portion of body 454. Fitting projections 461 are positioning projections 462 are formed on cover 457 to correspond to fitting holes 460 and positioning holes 459, respectively. Fitting holes 465 and positioning holes 453 are formed in film 451 of the antenna apparatus to correspond to fitting holes 460 and positioning holes 459, respectively. This terminal box is inserted in an end portion of film 451, and terminal members 456 are elastically brought into contact with feeder portions 452 on the insulating film. When cover 457 is pivoted in an arrow direction and closed, fitting projections 461 of cover 457 are fitted in fitting holes 460 of body 454 to keep the cover closed. In addition, positioning projections 462 of cover 457 are fitted in positioning holes 453 of the insulating film and in positioning holes 459 of body 454 to fix the terminal box and the insulating film in a predetermined positional relationship. In this case, the feeder terminal members are urged against feeder portions 452 more strongly by the cover. This terminal box can be easily attached/detached and hence can be electrically connected to the feeder portions formed on the rear surface of film 451.

Fig. 20 shows an antenna system using the antenna apparatus of the present invention. In Fig.

20, reference numeral 481 denotes an insulating film; 482, an antenna; and 483, a terminal box. A feeder connected to terminal box 483 is connected to a receiving apparatus, e.g., television receiver 485 through switch 484 for switching a plurality of positions (e.g., 15 positions). According to this system, switch 484 is operated to switch an antenna terminal, thereby controlling directivity.

Figs. 21 and 22 show still another embodiment of an antenna apparatus. In this antenna apparatus, two sets of antennas 432 are formed on film 431 and connected to mixer 435 through feeder portions 433. That is, since a signal is received by the two sets of antennas, sensitivity is improved. In this embodiment, two-side adhesive tape 436 is adhered on an edge portion of the rear surface of film 431 and backing paper 437 is adhered thereon. By removing the backing paper, this apparatus can be adhered on a wall or the like by tape 436.

Figs. 23 and 24 show an embodiment of a feeder suitable for an antenna apparatus of the present invention. The antenna apparatus of the present invention is thin, can be adhered on a wall or the like, and hence rarely degrades a room interior design. Therefore, if a conventional feeder is used with this antenna apparatus, a room interior design is degraded because the feeder is conspicuous. A feeder of this embodiment comprises thin band-like insulating coating 501 made of an elastic synthetic resin or the like. Thin foil-like conductor 502 made of a metal material is embedded in coating 501. Two-side adhesive tape 503 is adhered on the rear surface of coating 501, and backing paper 504 is adhered thereon. By removing backing paper 504, the feeder can be adhered directly on a wall or the like by tape 503. In addition, this feeder is thin and hence does not degrade a room interior design. Note that if a transparent material is used as member 501, the feeder becomes more conspicuous.

Fig. 25 shows an embodiment in which the antenna of the present invention is incorporated behind picture frame 511. According to this embodiment, antenna 512 is connected to feeder 514 through terminal box 513 provided on the rear surface of the picture frame. Hooks 515 for hanging the picture frame are provided thereto.

Fig. 26 shows an embodiment in which the antenna apparatus of the present invention is incorporated in another product. In Fig. 26, reference numeral 521 denotes a television receiver; and 522, a base of receiver 522. Antenna apparatus 523 according to the present invention is incorporated in part of a cabinet of receiver 521, e.g., a side surface thereof. On the other hand, antenna apparatus 524 according to the present invention may be incorporated in a side surface of base 522. With this arrangement, the antenna apparatus cannot be

seen from outside. The antenna apparatus according to the present invention can be similarly incorporated in a variety of furniture.

Fig. 27 shows an embodiment in which antenna apparatus 532 is incorporated in game board 531 for chess, Othello, and the like.

Fig. 28 shows an embodiment in which antenna apparatus 543 of the present invention is incorporated in lamp shade 542 of desk lamp 541. In this case, feeder 545 to be connected to the antenna apparatus is preferably formed integrally with power source cord 544 of the desk lamp.

The antenna apparatus of the present invention can be formed to have a shape other than a flat sheet, e.g., rolled up like a cylinder as shown in Fig. 29 because it is flexible. In Fig. 29, reference numeral 562 denotes an insulating film; 563, an antenna; and 561, a mounting portion. This apparatus is mounted on a wall or the like through member 561. Since the antenna apparatus of this embodiment is cylindrical, horizontal omnidirectivity can be obtained. In addition, when a light source is arranged in this antenna apparatus, this antenna apparatus can be used also as an illumination apparatus.

In the above embodiments, an insulating film is used as an electrically insulating sheet. However, instead of the insulating film, cloth or non-woven fabric may be used. Fig. 30 shows one embodiment thereof. In Fig. 30, reference numeral 611 denotes an insulating sheet made of cloth or non-woven fabric. Sheet 611 has embroideries 613a and 613b made of a conductive material and hence can be used as a tapestry. Antennas 613a and 613b made of a conductive material are formed in sheet 611. Note that reference numerals 614a and 614b denote feeder terminals of the antennas. Each antenna portion is formed by weaving a conductive string obtained by coating a metal material on a thin metal wire or thin fabric. It is a matter of course that the antenna may be formed by adhering a metal foil or depositing a metal film as in the above embodiments.

Fig. 31 shows an embodiment in which the antenna of the present invention is incorporated in an umbrella. In Fig. 31, reference numeral 621 denotes cloth of an umbrella, and antennas 622a, 622b, 624, and 625 are formed in this cloth similar to the embodiment of Fig. 30. In this embodiment, the antenna apparatus constitutes a Yagi-type antenna. That is, antenna 624 constitutes a director, and antenna 625 constitutes a reflector. Note that reference numerals 623a and 623b denote feeder terminals.

It is obvious that the present invention is not limited to the above embodiments but can be var-

iously changed and modified by a person of an ordinary skill in the art without departing from the spirit and scope of the present invention.

## Claims

1. An antenna apparatus in which antennas are formed on a flat insulating member, characterized in that said insulating member (11) is constituted by a thin flexible insulating sheet which can be freely bent or folded and said antennas (12a, 12b) are made of a thin flexible conductive material and formed on said insulating sheet.

2. An apparatus according to claim 1, characterized in that said insulating sheet (11) is a thin insulating film made of a synthetic resin material.

3. An apparatus according to claim 1, characterized in that said insulating sheet (11) is paper.

4. An apparatus according to claim 1, characterized in that said insulating sheet (11) is cloth.

5. An apparatus according to claim 1, characterized in that said insulating sheet (11) is non-woven fabric.

6. An apparatus according to claim 1, characterized in that said antennas (12a, 12b) are made of a metal foil.

7. An apparatus according to claim 1, characterized in that said antennas (12a, 12b) are made of a conductive film coated on said insulating sheet.

8. An apparatus according to claim 4, characterized in that said antennas (12a, 12b) are constituted by conductive strings woven in said cloth.

9. An apparatus according to claim 7, characterized in that said conductive film is a metal film deposited on said insulating sheet.

10. An apparatus according to claim 1, characterized in that said antennas (12a, 12b) are dipole antennas and at least part thereof is bent to form a wave-like bent portion (13a, 13b).

11. An apparatus according to claim 10, characterized in that a linear short-circuit portion (203) is formed at least at part of said wave-like bent portion (202).

12. An apparatus according to claim 1, characterized in that a terminal box (213) is detachably provided on an edge portion of said insulating sheet (211) to electrically connect said antennas with a feeder.

13. An apparatus according to claim 1, characterized in that printing is performed on said insulating sheet (111).

14. An apparatus according to claim 1, characterized in that said insulating sheet is incorporated in furniture or another product.

15. An apparatus according to claim 1, characterized in that said insulating sheet is formed to have a three-dimensional shape.

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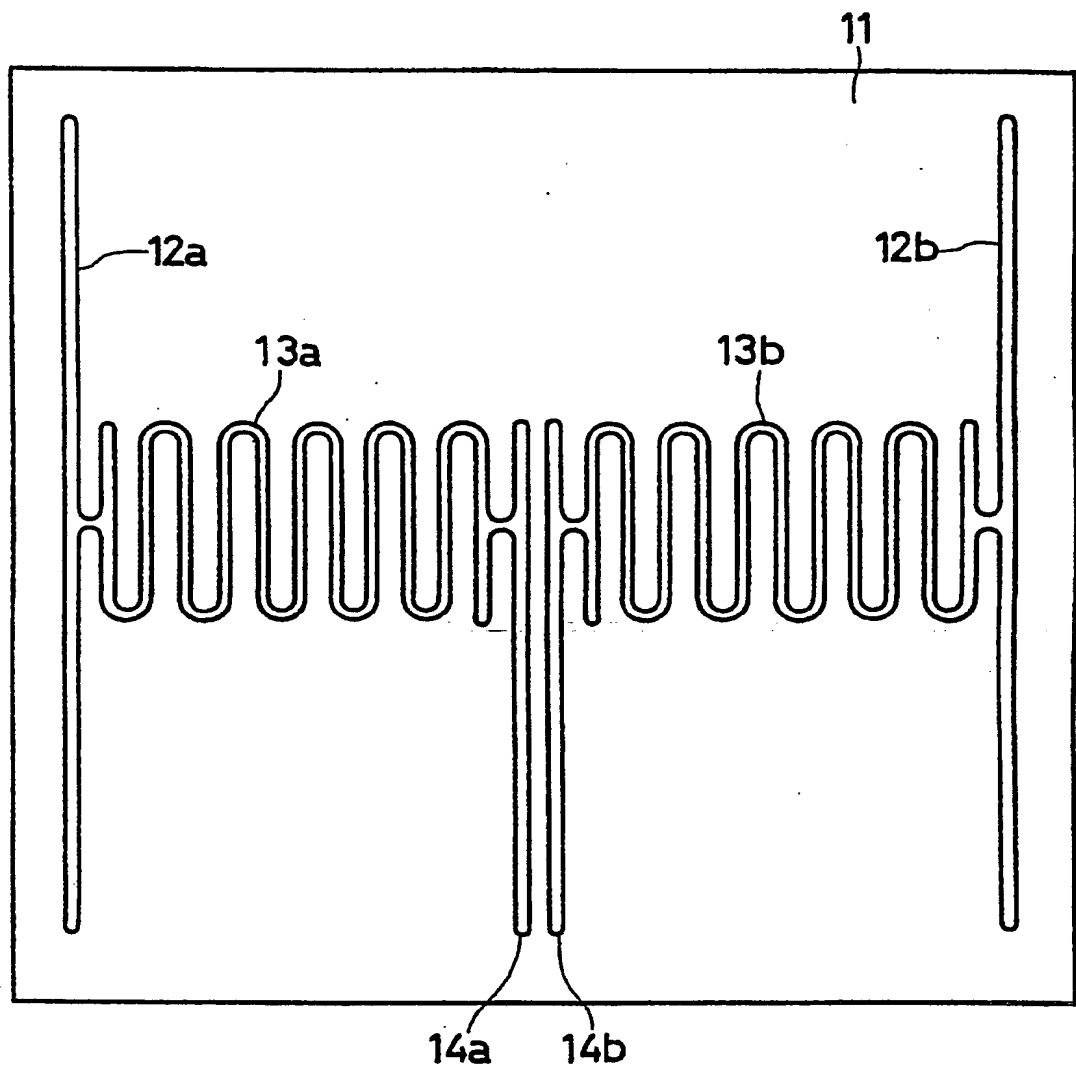
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F I G. 1

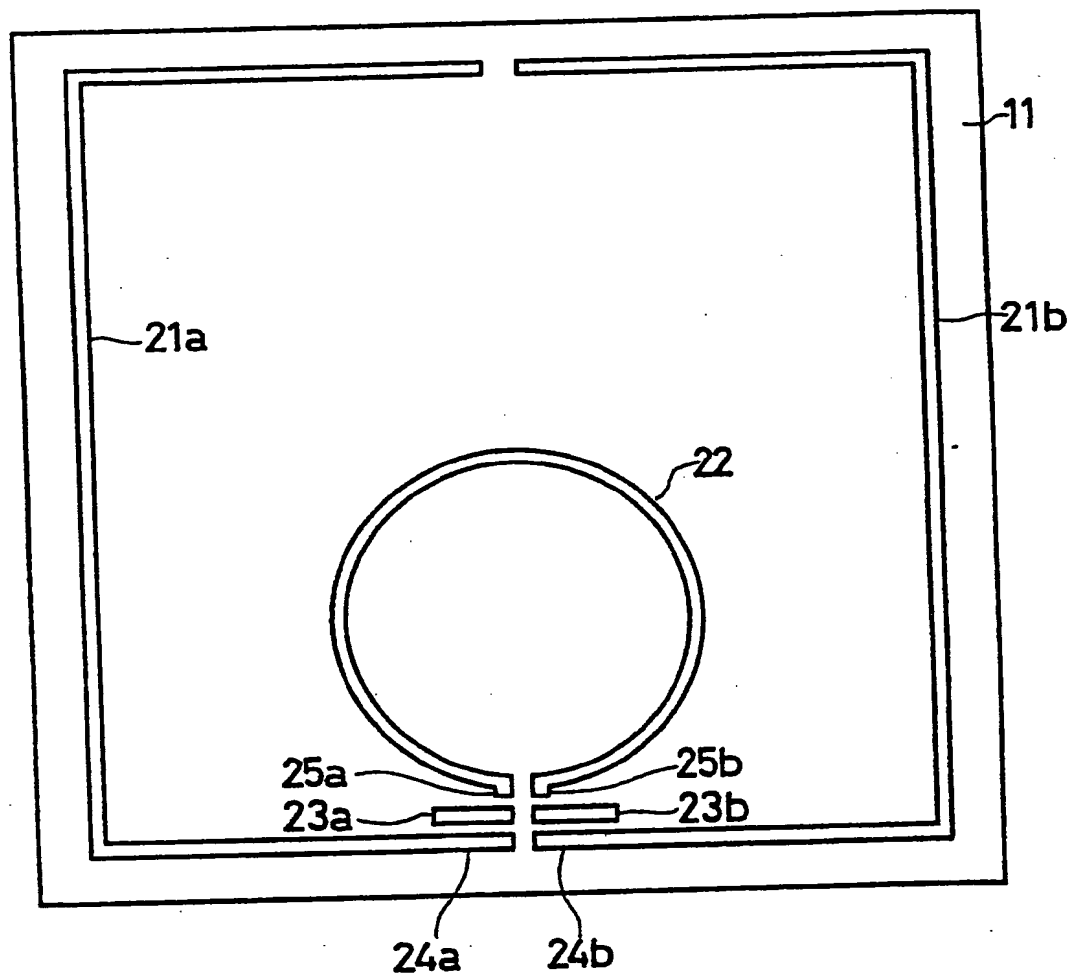


FIG. 2

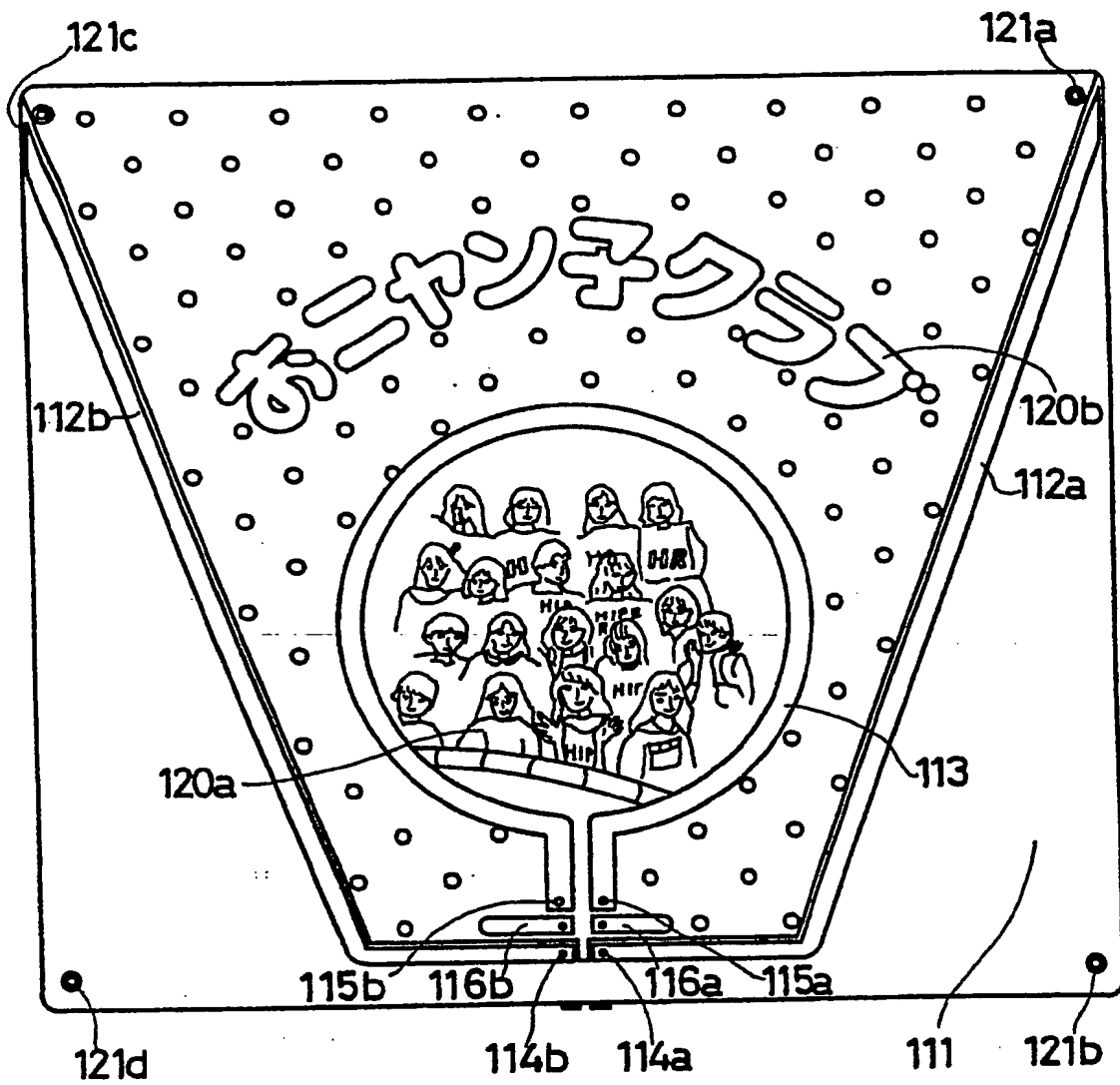


FIG. 3

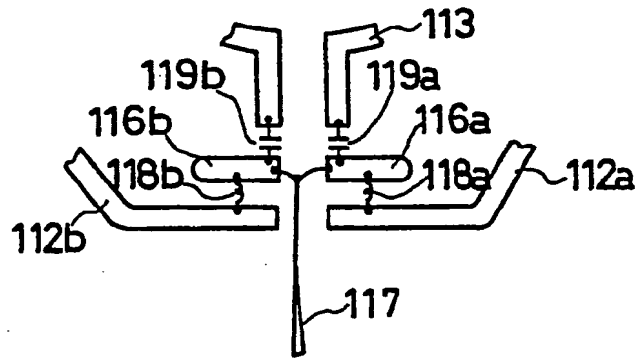


FIG. 4

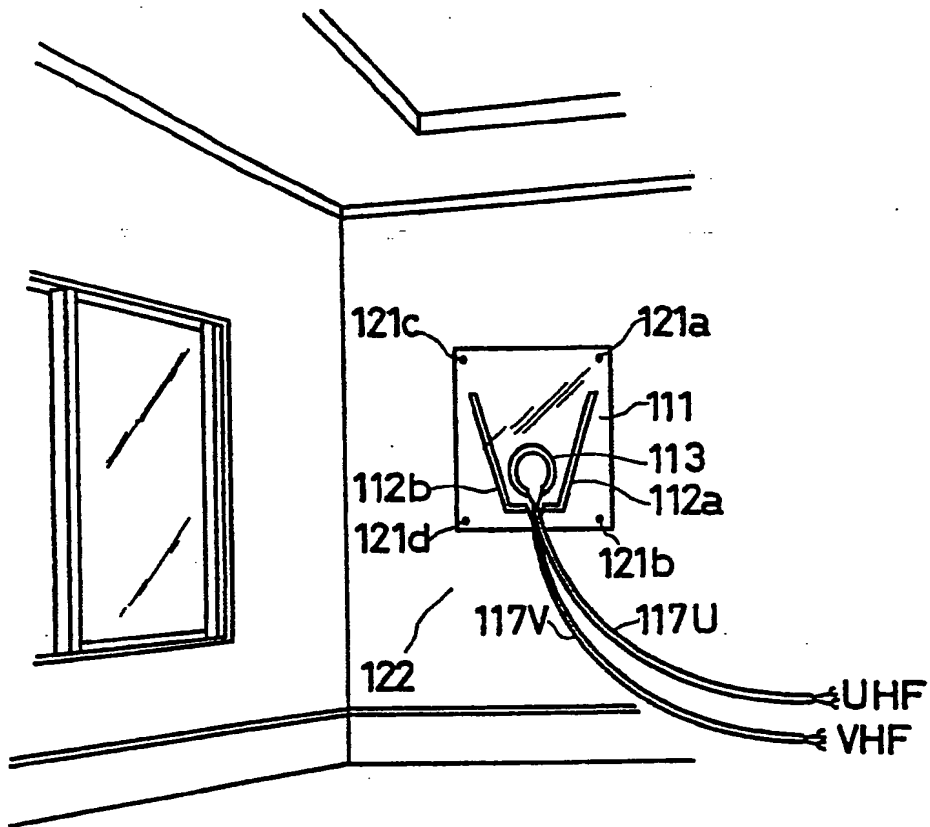
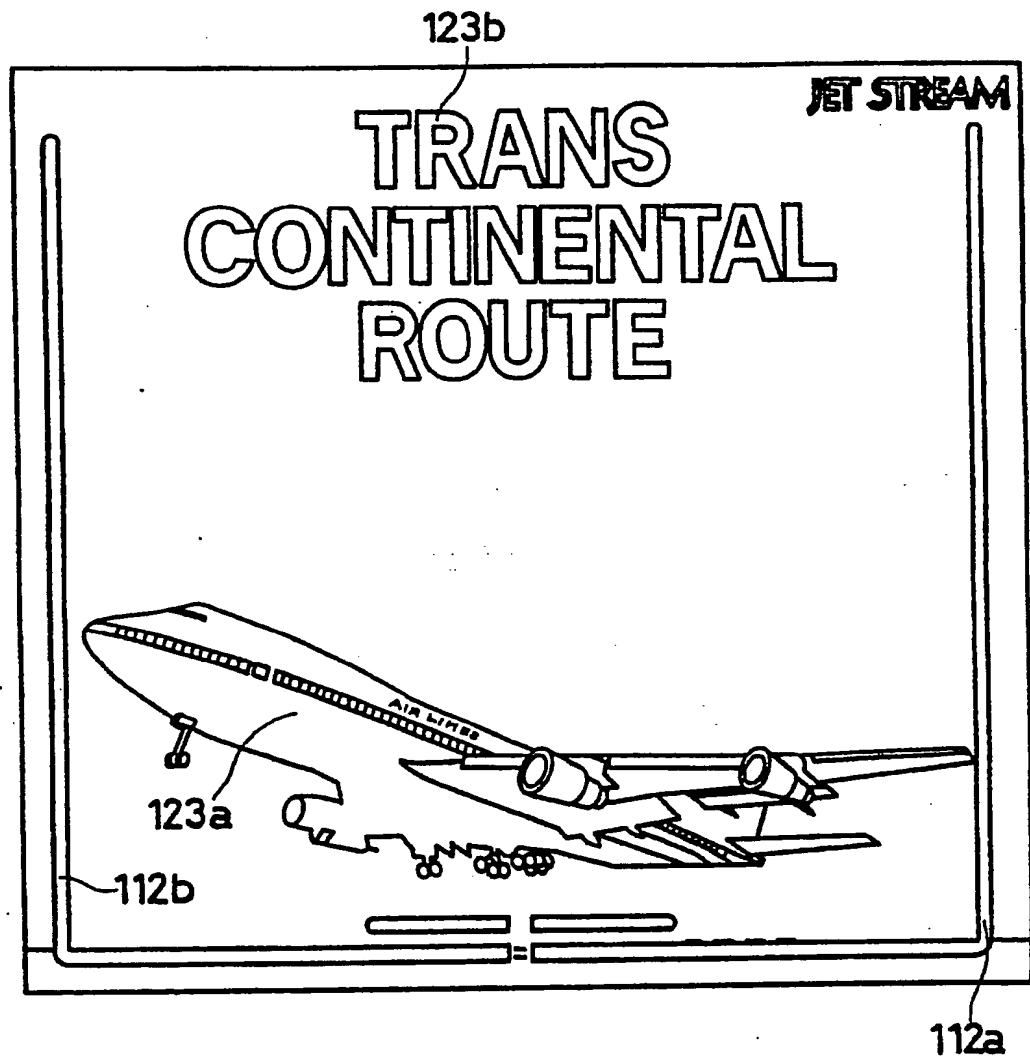


FIG. 5



F I G. 6

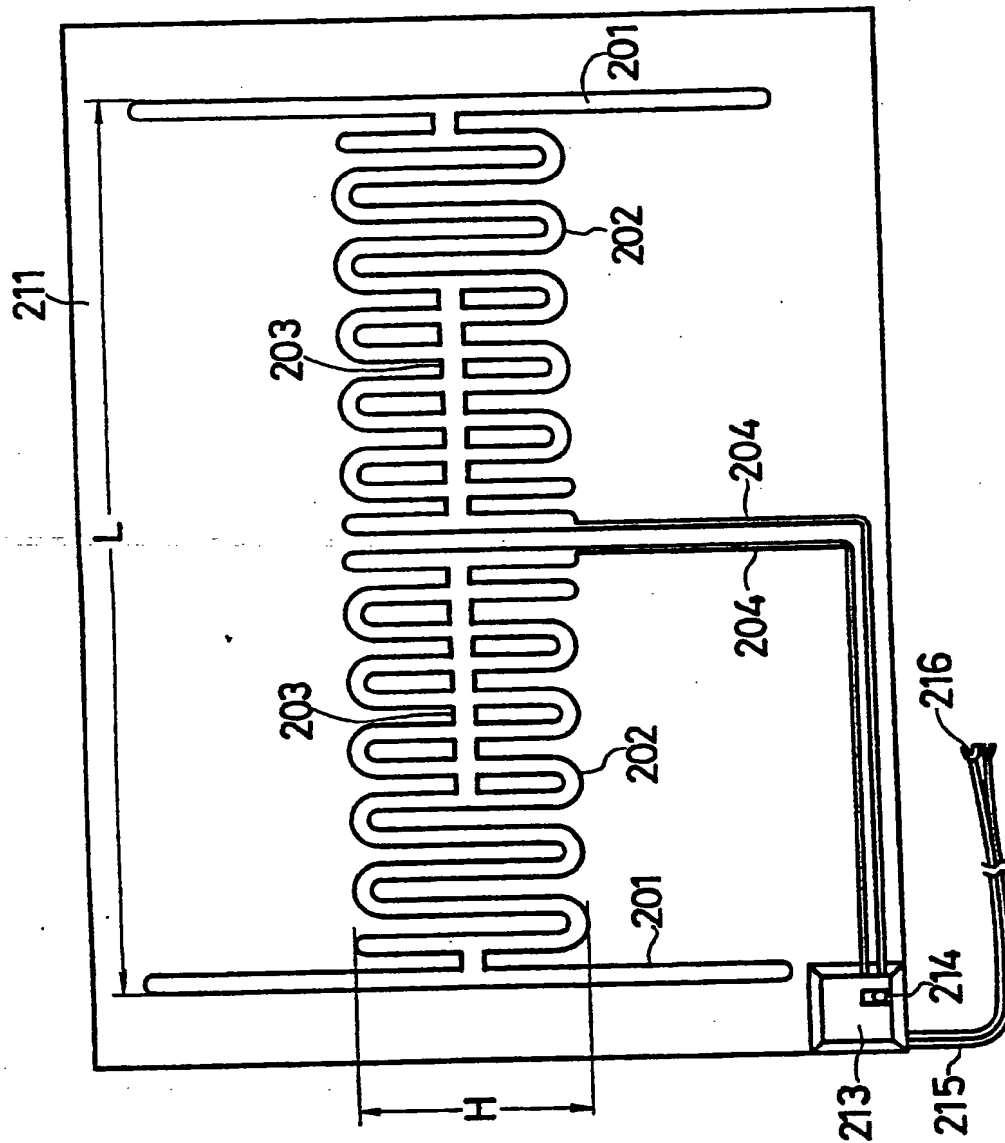


FIG. 7

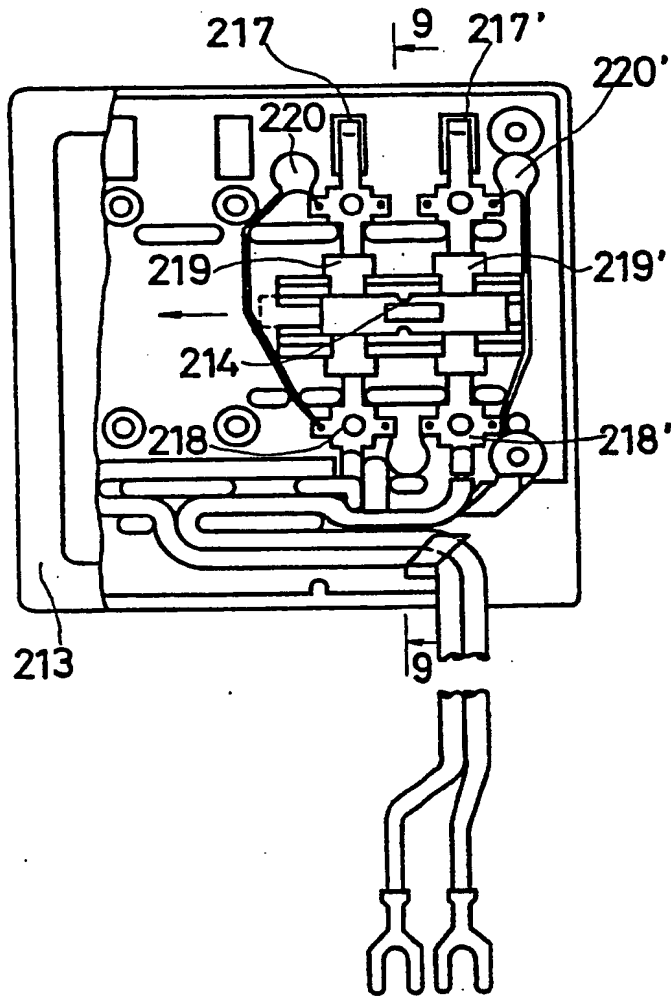


FIG. 8

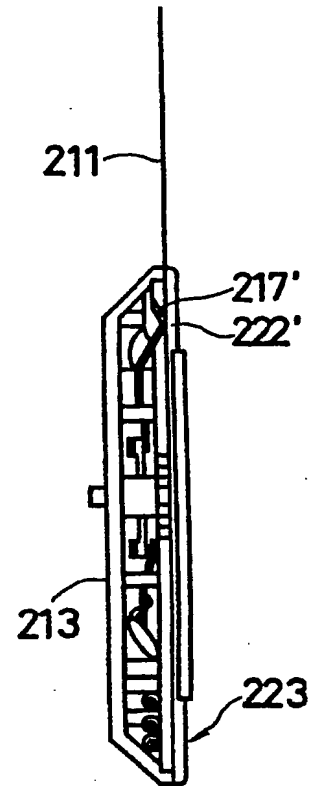


FIG. 9

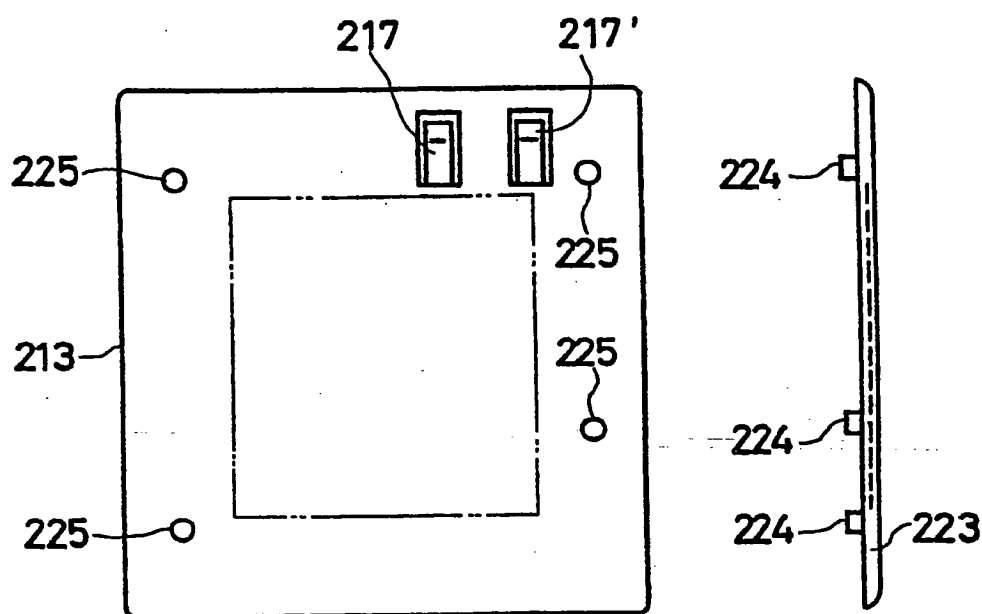


FIG. 10

FIG. 11



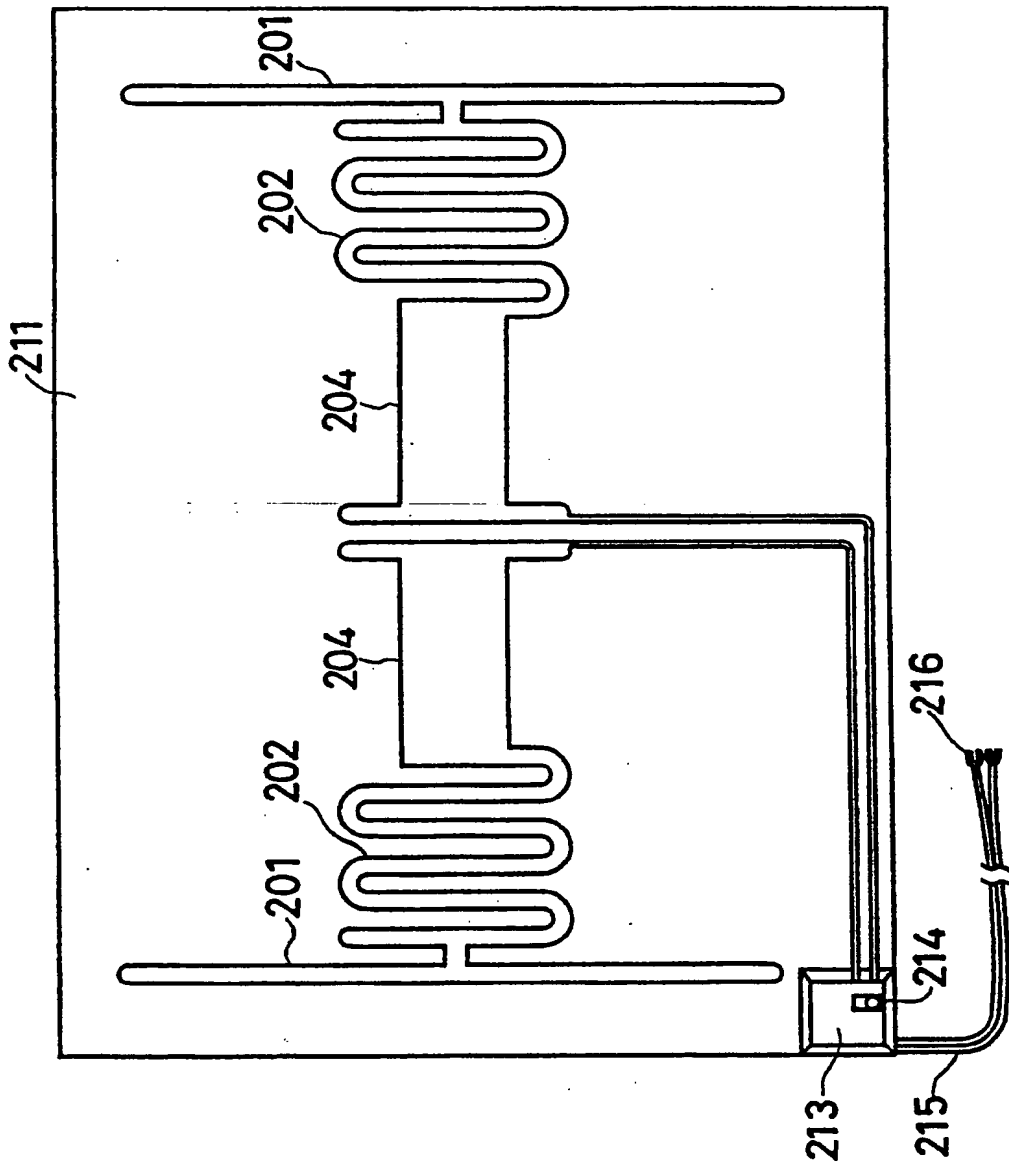


FIG. 12

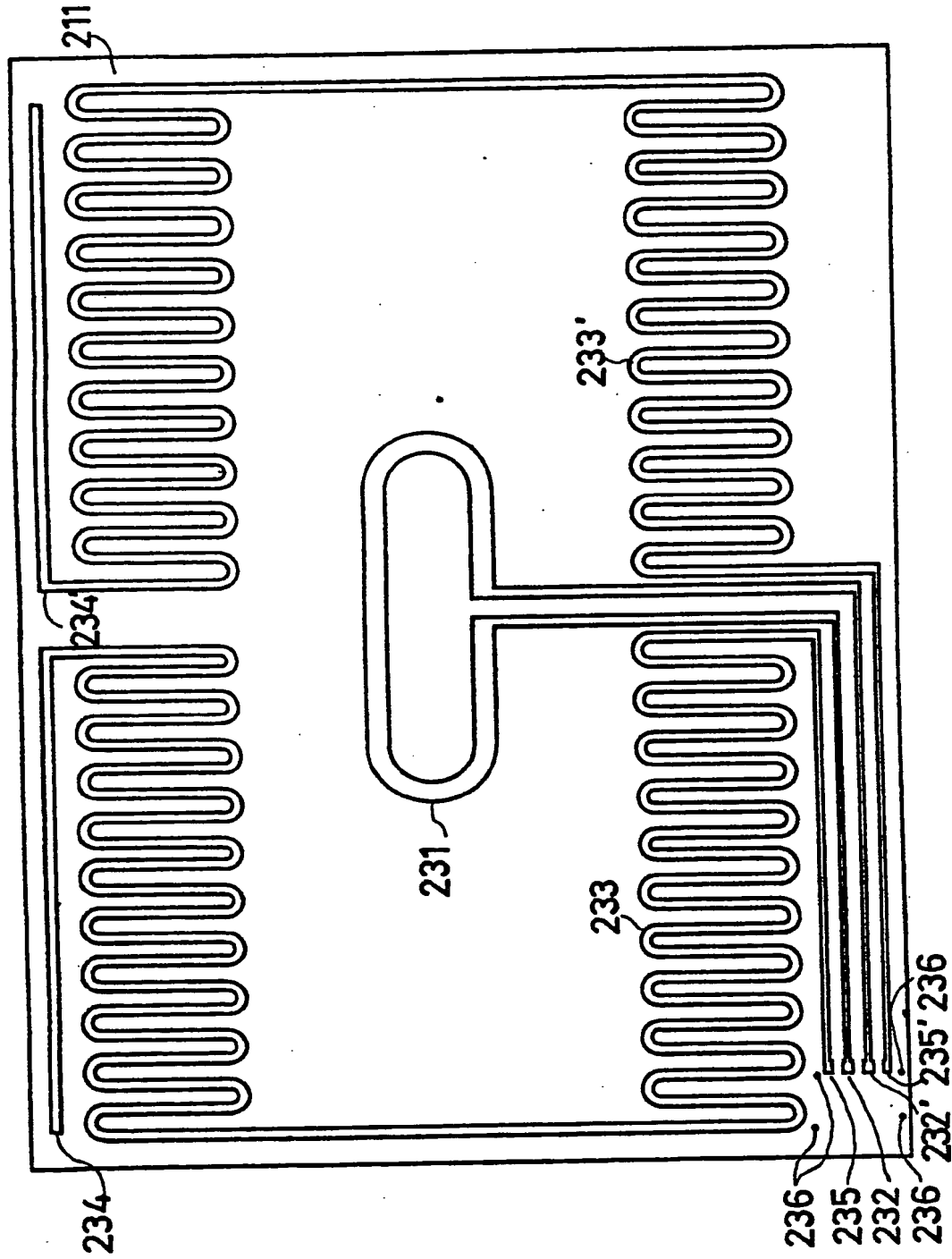
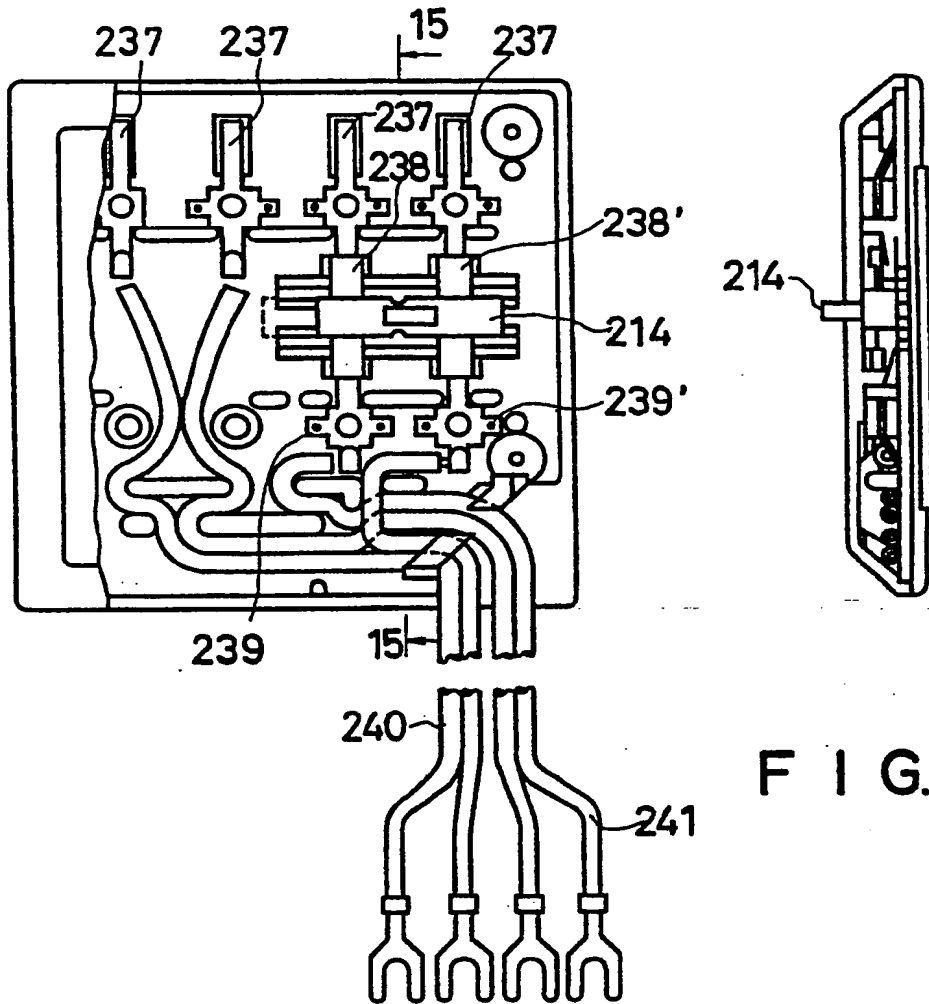


FIG. 13



F I G. 14

F I G. 15



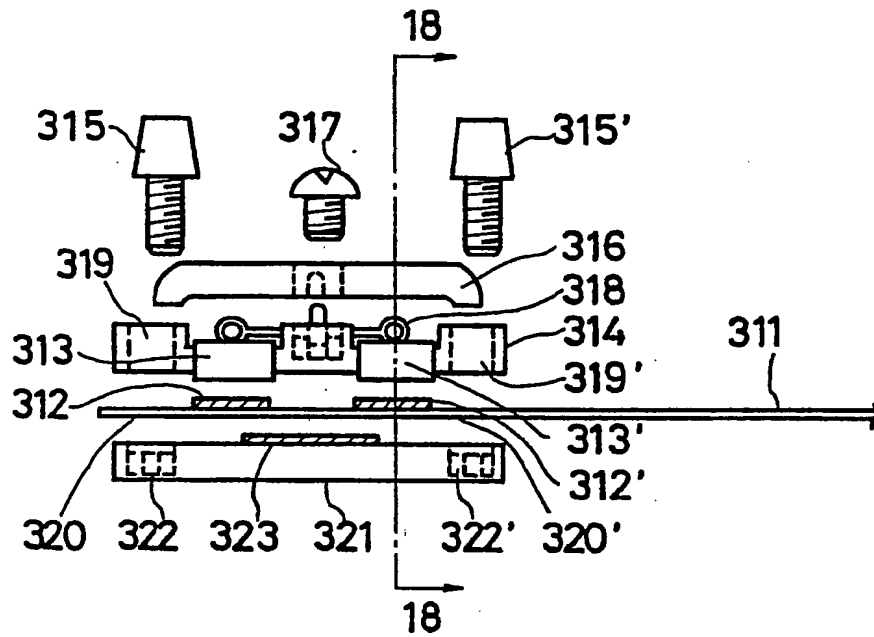


FIG. 17

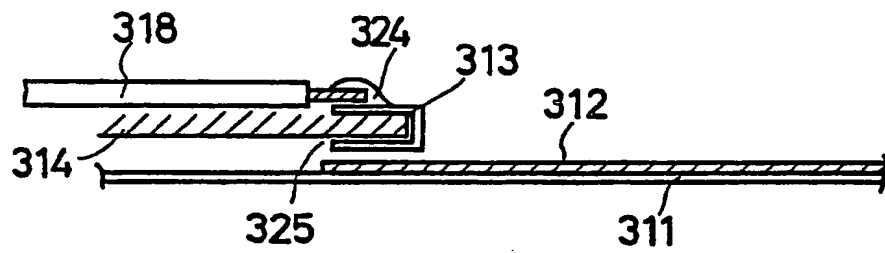


FIG. 18

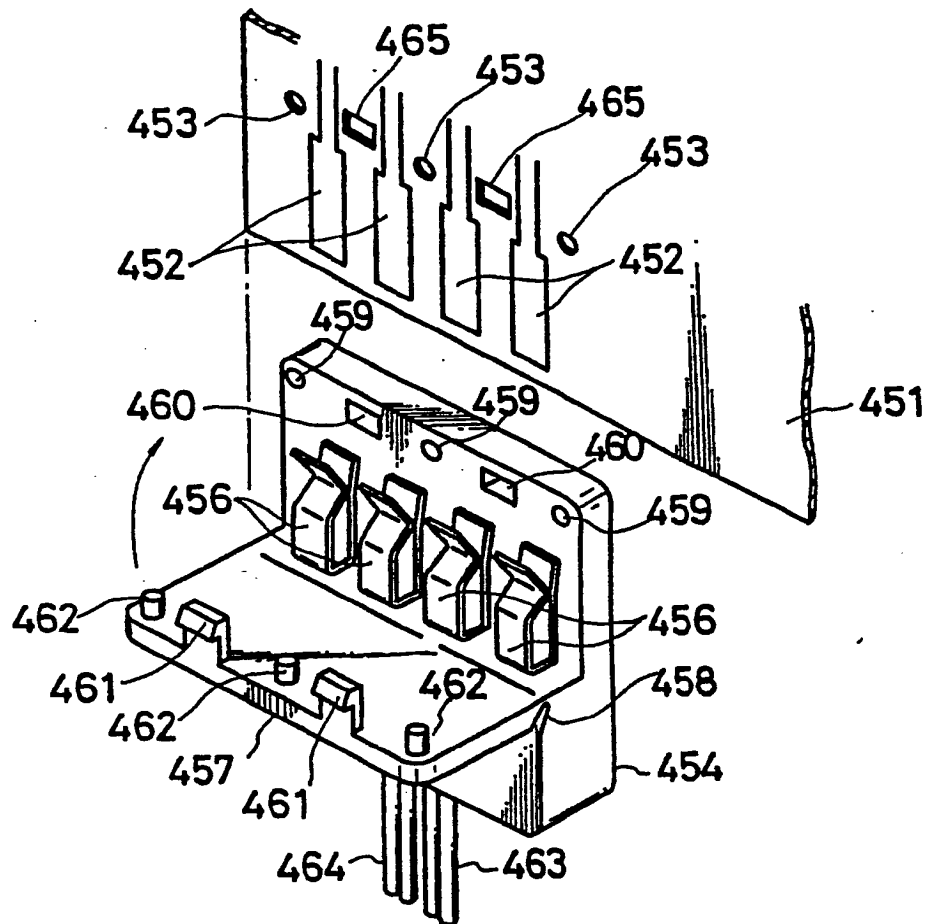
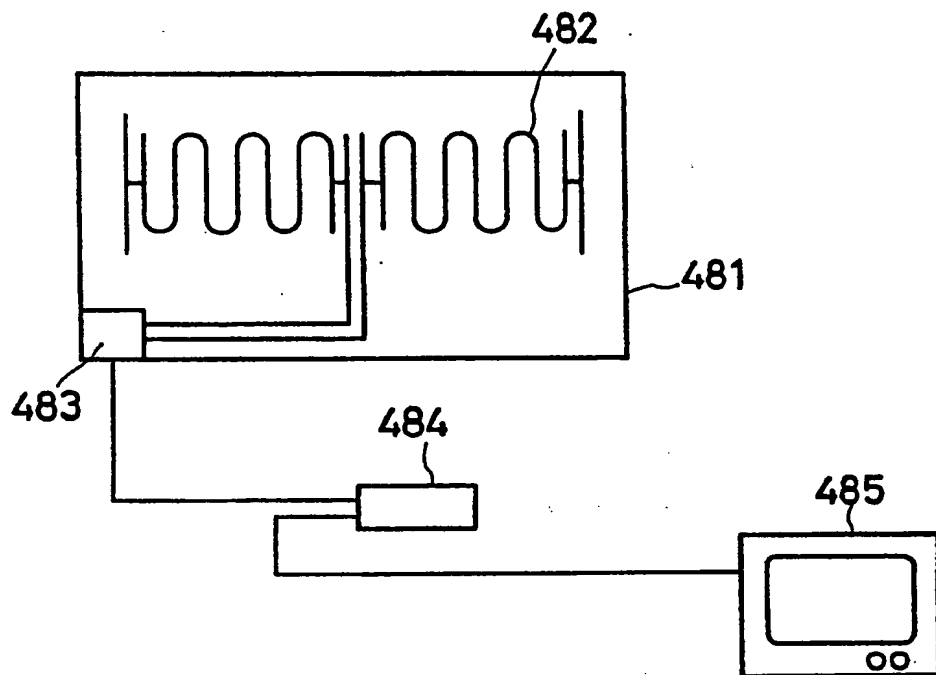


FIG. 19



F I G. 20

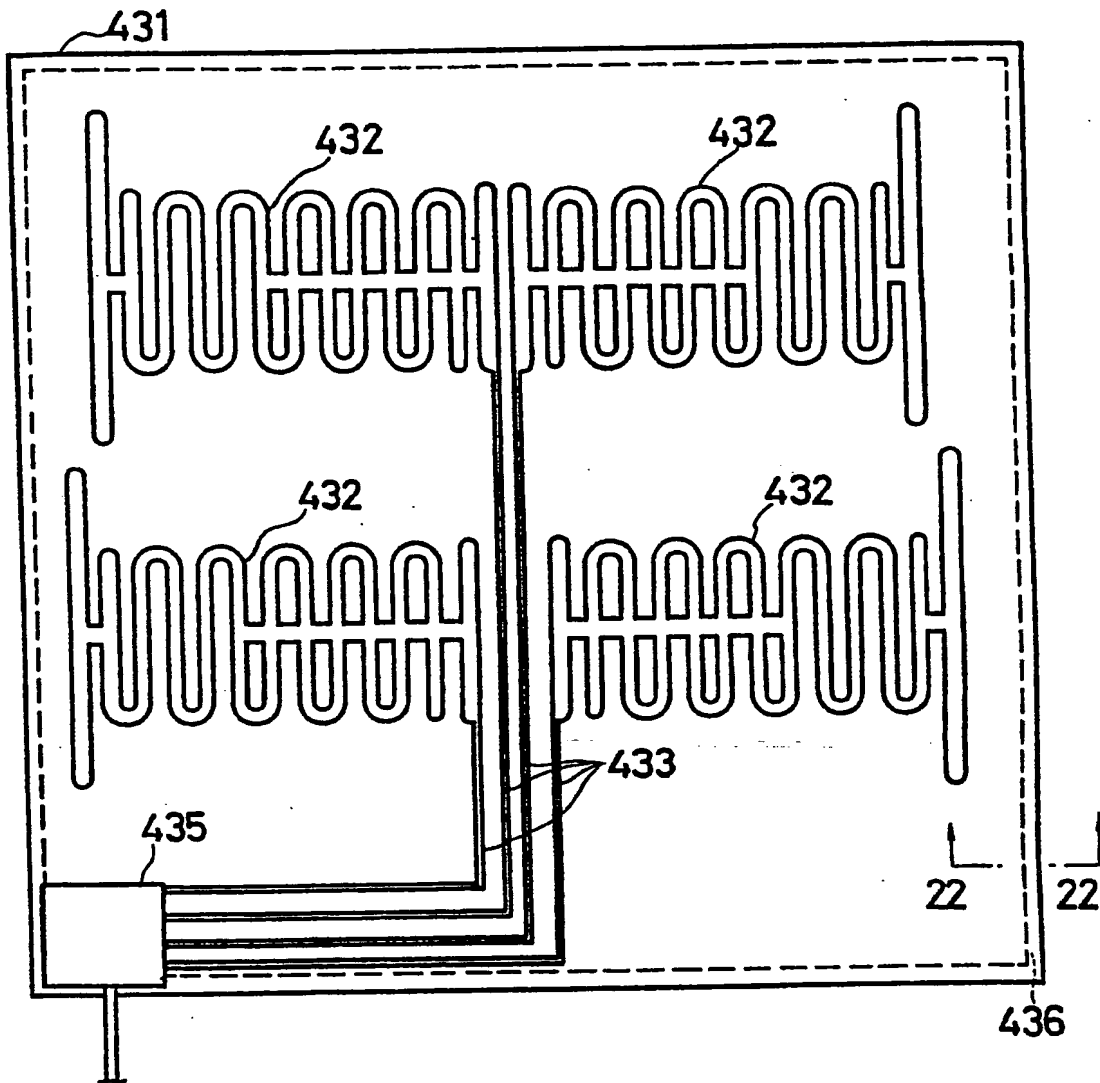


FIG. 21

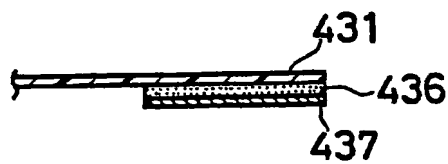


FIG. 22



FIG. 23

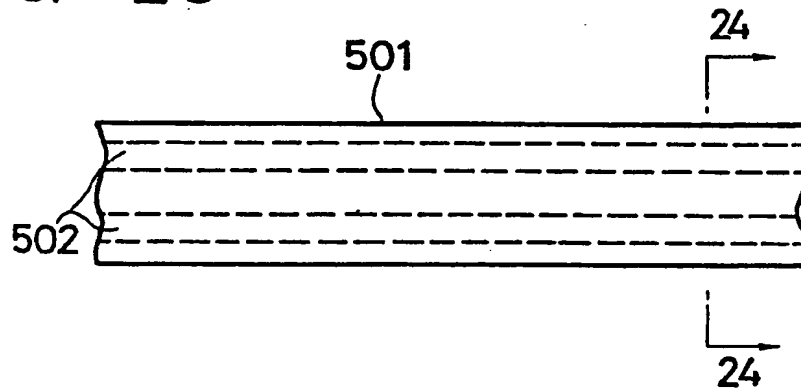


FIG. 24

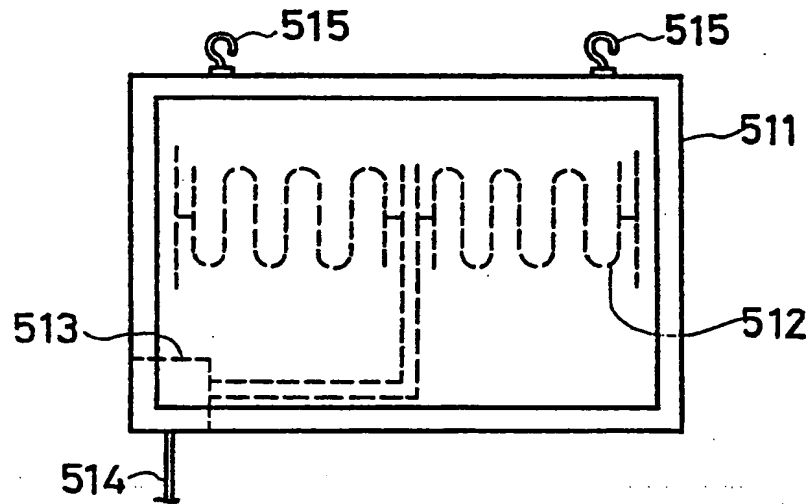
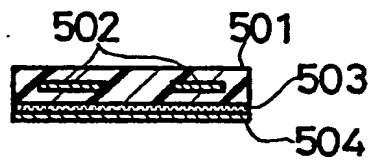
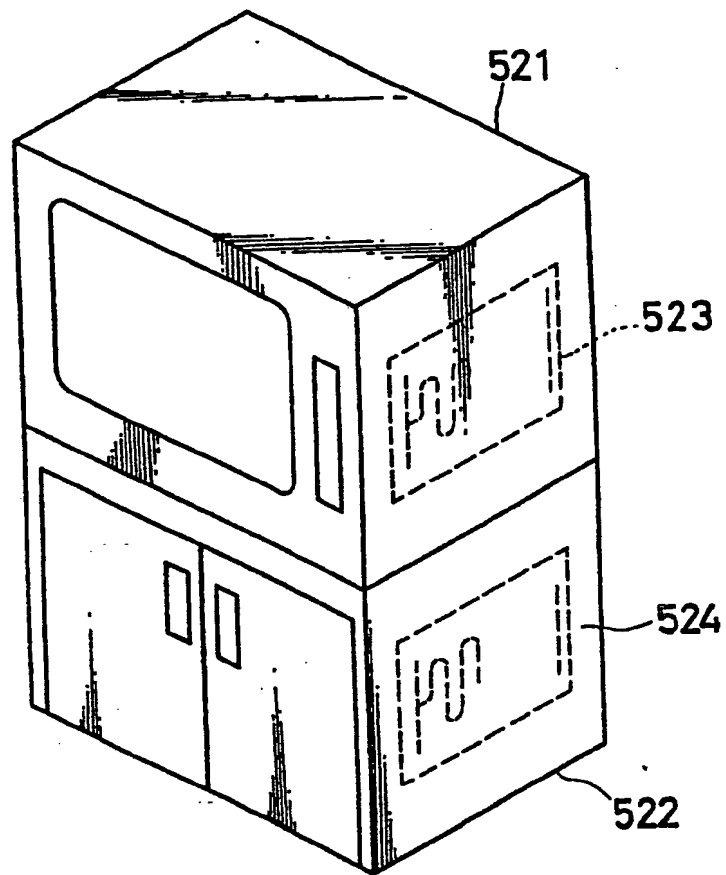


FIG. 25



F I G. 26

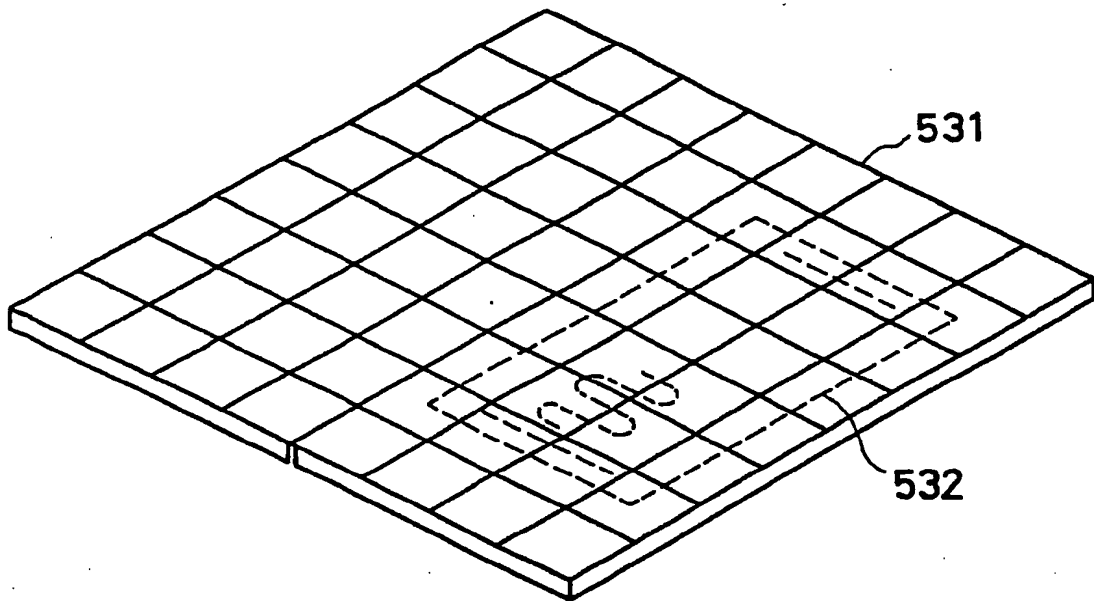


FIG. 27

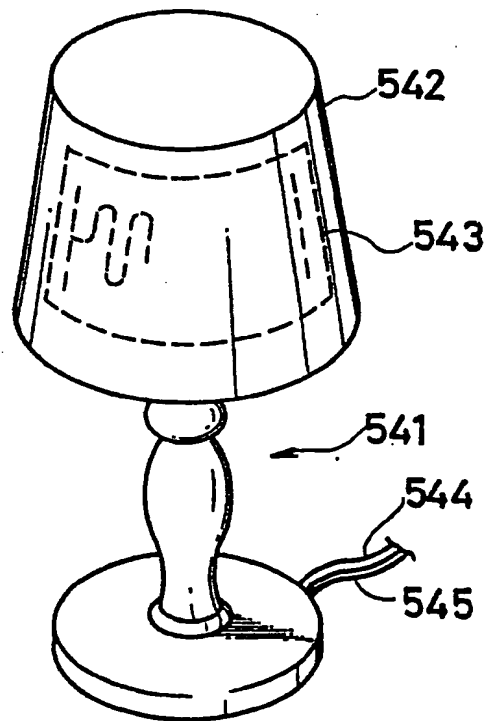
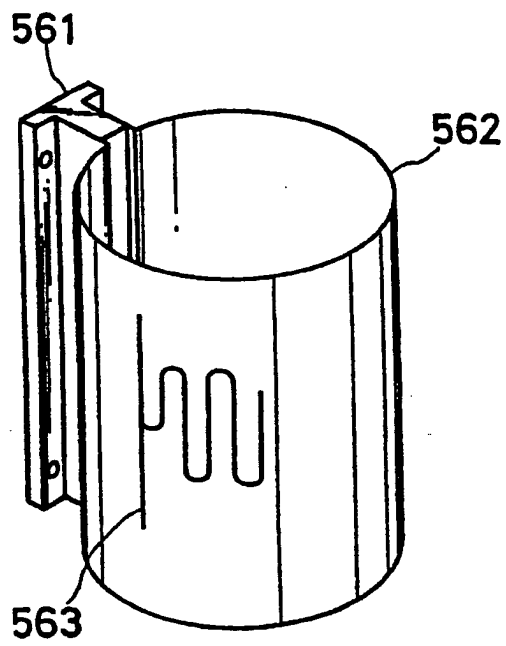


FIG. 28



F I G. 29

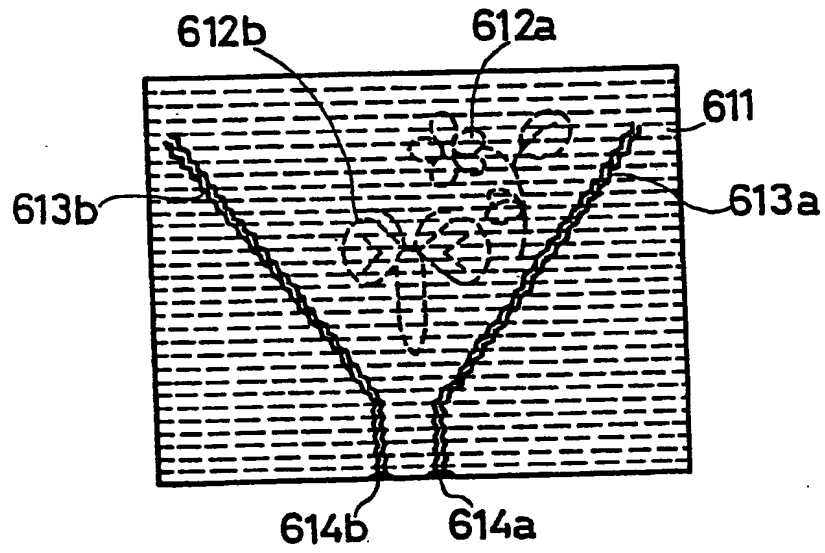


FIG. 30

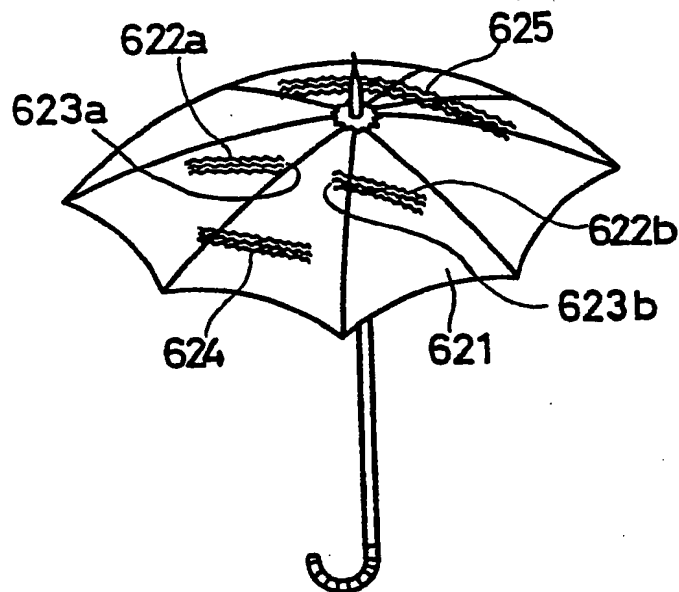


FIG. 31



European Patent  
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# EUROPEAN SEARCH REPORT

Application Number

EP 87 11 6278

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	PATENT ABSTRACTS OF JAPAN, vol. 6, no. 254 (E-148)[1132], 14th December 1982; & JP - A - 57 152 706 (TEII SHII DENSHI) 21-09-1982	1	H 01 Q 1/08 H 01 Q 9/06
A	US-A-3 815 141 (KIGLER) * figure 1, column 2, lines 40-56, 47-51 *	2,6	
A	PATENT ABSTRACTS OF JAPAN, vol. 5, no. 129 (E-70)[801], 19th August 1981; & JP - A - 56 65502 (MATSUSHITA DENKO) 03-06-1981	3	
A	US-A-4 038 662 (TURNER) * figure 1; column 3, lines 18-25 *	10	
D,A	US-A-3 780 373 (HOLST et al.) * figure 3; column 1, lines 13-17 *	13	
A	US-A-4 546 357 (LAUGHON et al.) * figure 1, abstract *	14	
D,A	US-A-3 587 105 (NEILSON) * figure 1, abstract *		
A	US-A-1 683 270 (TAYLOR et al.) * figure 1 *		
A	US-A-3 261 019 (LUNDY) * figure 2; column 1, lines 64-67 *		
The present search report has been drawn up for all claims			
Place of search BERLIN		Date of completion of the search 25-03-1988	Examiner BREUSING J
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